Development of the Medical Imaging Extension for OMOP-CDM

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Background

Medical Imaging plays an essential part of medical care in diagnosing and measuring disease as well as the response to medical interventions. The OHDSI medical imaging WG has developed an extension to the OMOP CDM to support incorporating medical imaging studies as well as measurements derived from medical imaging

The steps taken to create this extension were

1. Create use cases of that this data model is intended to be able to answer for observational research.
2. Identify the vocabularies needed to support clinical findings. RadLex is employed as a comprehensive vocabulary of radiology terminology which has been developed and maintained by the RSNA.
3. Create data models required to be able to support the use case questions.

Primary Use Case

The primary use case we created was tracking of pulmonary nodules over time that require treatment. This is a good example as patients can have multiple clinical findings within any given imaging study and each clinical findings can have multiple features that describe that finding.

An imaging study includes a collection of medical images, and each study can have multiple clinical findings (nodules). Each imaging finding can have multiple imaging features (attributes size, composition, location).

An example Pulmonary Nodule is a 55-year-old patient that quit smoking 8 years ago.

Patient's 1st visit (2021-01-06): Patient went to the ED with abdominal pain, had an Abdomen Pelvis Combination Procedure Occurrence CPT 74176 where the Radiology Report found:

1. RDE1302: 8mm nodule in the RDE1304: lower left lobe and recommended follow-up.

2nd visit (2021-04-07): Procedure Occurrence CPT 71250, Chest without contrast. Radiology report found:

1. RDE1302: 8mm, RDE1301: solid nodule in RDE1304: lower left lobe (Measurement Radlex RDE)
2. RDE1302: 7mm, RDE1301: ground glass nodule in RDE1304: right upper lobe

3. RDE1302: 11mm, RDE1301: solid nodule in RDE1304: right upper lobe

3rd visit (2021-10-14): Procedure Occurrence CPT 71250, Chest without contrast. Radiology report found:

1. RDE1302: 8mm, RDE1301: solid nodule in RDE1304: lower left lobe
2. RDE1302: 1.2 mm, RDE1301: part solid nodule in RDE1304: right upper lobe
3. RDE1302: 11mm, RDE1301: solid nodule in RDE1304: right upper lobe

4th visit (2021-10-28): Procedure Occurrence CPT 32485 CT Guided Percutaneous Needle Lung Biopsy. Pathology report showed: Condition Occurrence ICD10 C34. 11 for Malignant neoplasm of upper lobe, right bronchus or lung

5th visit (2021-11-28): Procedure Occurrence CPT 77373 Stereotactic body radiation therapy delivery

6th visit (2022-04-07): Procedure Occurrence CPT 71250, Chest without contrast. Radiology Report found:

1. RDE1302: 8mm, RDE1301: solid nodule in RDE1304: lower left lobe
2. RDE1302: 7mm, RDE1301: solid nodule in RDE1304: right upper lobe
3. RDE1302: 11mm, RDE1301: solid nodule in RDE1304: right upper lobe

Proposed Data Model. The data model includes two tables.

Imaging Study table. The goal of this table is to provide the provenance to the imaging study performed in a DICOM format presumably storied on a PACS (Picture Archiving and Communication System) or a Vendor Neutral Archive (VNA). Imaging Studies are stored in a DICOM format as a series of files in a Study -> Series -> Image style. There can be many images taken in a series with multiple series taken within an imaging study. The second goal of the table is to provide a link to procedure_occurrence entries. There is a cardinality relationship between procedure_occurrence and imaging study where one imaging study may represent one or more procedure occurrrences. Each procedure occurrence is represented by a single procedure code often in a Current Procedure Terminology (CPT) format. The Imaging Study ID is often referred to locally within imaging systems as the Accession Number. In the DICOMWeb standard there is the ability to provide a Uniform Resource Identifier (URI) with an hyper text transfer protocol (HTTP) Uniform Resource Locator (HTTP). The intention of this table is to point to the origin source image pixel data that was performed on the date of image acquisition.

Imaging Feature table. The goal of this table is to take features derived from medical images and link to the measurement domain while providing provenance of those features back to the imaging pixel data in the imaging study. The Imaging Feature table has groupers that enables imaging features to be grouped into imaging findings with multiple unique imaging findings allowable for a given imaging study. The use reflects the complexity of multiple pulmonary nodules with multiple attributes for the same patient, one being highly suspicious, and tracking those nodules longitudinally. The goal would be to assess the impact of the intervention on that nodule. The Imaging Feature table also allows for the features created from computer algorithms to be identified by the algorithm and to an algorithm URI to enable reconstruction of features from computer algorithms.

Conclusion

We propose medical imaging extension to standardize features and provenance of medical images in OMOP-CDM. With further development, we hope that medical image extension provides essential

infrastructure for robust, scalable, and reproducible medical image study.

References/Citations

1. Pryor TA, Gardner RM, Clayton RD, Warner HR. The HELP system. J Med Sys. 1983;7:87-101. Park C, You SC, Jeon H, Jeong CW, Choi JW, Park RW Development and Validation of the Radiology Common Data Model (R-CDM) for the International Standardization of Medical Imaging Data. Yonsei Medical Journal 63, no. Suppl (January 1, 2022): S74-0.
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